SURF 2008

HEALTH ISSUES RAISED BY POORLY MAINTAINED ROAD NETWORKS

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ROADEX III
NORTHERN PERIPHERY

Outline

Northern Periphery Roadex III project partners.

Health and safety aspects on ride vibration.

10 truck roundtrips of the 280 km *Beaver Road*:

- **Truck ride vibration above the EU Action Value.**
- **Bumps gave high compression stress in the spine.**
- **Intense roll vibration at Hazardous Sites, caused by Rut Bottom Cross Slope Variance.**

Safety issues related to improperly banked curves.

Roadex III partners
-Creating affordable and reliable roads

SRA Northern Region, Lead Partner Swedish Forest Agency	Vägverket, SKOGSSTYRELSEN SWEDISH FOREST AGENCY
FINNRA, Savo-Karjala District	FINNISH ROAD ADMINISTRATION
The Municipality of Sisimiut	
The Icelandic Public Roads Administration	VEGAGERÐIN
NRA Northern Region	
The Highland Council, Forest Enterprise, The Western Isles Council	The Highland Council, Forest Enterprise

Disproportionate health and safety risks

Northern Periphery truckies suffer increased risk of stress related heart disease and back pain.

153 % higher risk to die in a crash in rural NP areas, than in the metropols Stockholm & Gothenburg.

Photo: Niklas Thunborg.

2008-10-20:
Car driver killed by HGV, skidding on slippery "Black ice" at the Beaver Road 331.

Health and safety aspects on ride vibration

Figure from the EU Guide to good practice on WBV.

Truck seat vibration often in the ISO 2631 *Health Caution Zone*.
Bounce, Pitch and Roll motions.
Roll accompanied by lateral forces / buffeting.
Frequency range 0.5 - 80 Hz.
Resonance in eye globes, spine, stomach etc.
Bumps – stressing effect.
Undulations – create drowsiness.

Tests at the Beaver Road 331

A regional 140 km route from Forest to Coast in Västernorrland County, Sweden.

Figure from SVT.

Annual Average Day Traffic, AADT, ranging from 350 to 2000 vehicles/day.

Speed limits mainly 90 and 70 km/h.

Accident locations: Clustered, not randomized

The Viksjö Haz. Sites

The Roos Curve Haz. Site

Road user behaviour at Rd 331

Avoiding pavement edge deformation.

Test partner: Brorssons Åkeri AB

14 timber logging trucks with trailers.

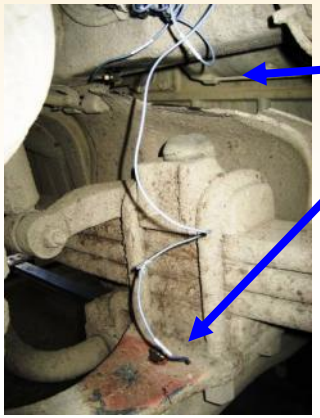
Each truck runs 18 hrs/day.
Four runs of 2 * 140 km daily at the *Beaver Road* 331.

Brorssons´s annual mileage on Rd 331: 2 800 000 km.

Test truck: Scania R480 164 G 6x4

Gross Vehicle Weight 60 ton, incl trailer and 41 ton timber payload.
609 000 km mileage, at 3 years age.

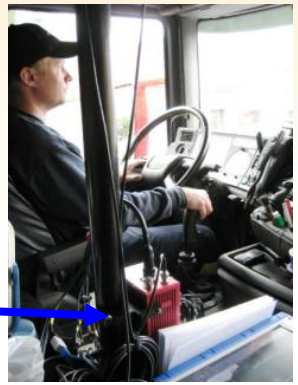
Truck ride sensors



Z-axis 5 kHz at frame, L & R.

Z-axis at front wheel axles.

GPS + 6-axis 100 Hz
inertial unit in the cab.



X, Y, Z-axis 1 kHz seat pad.

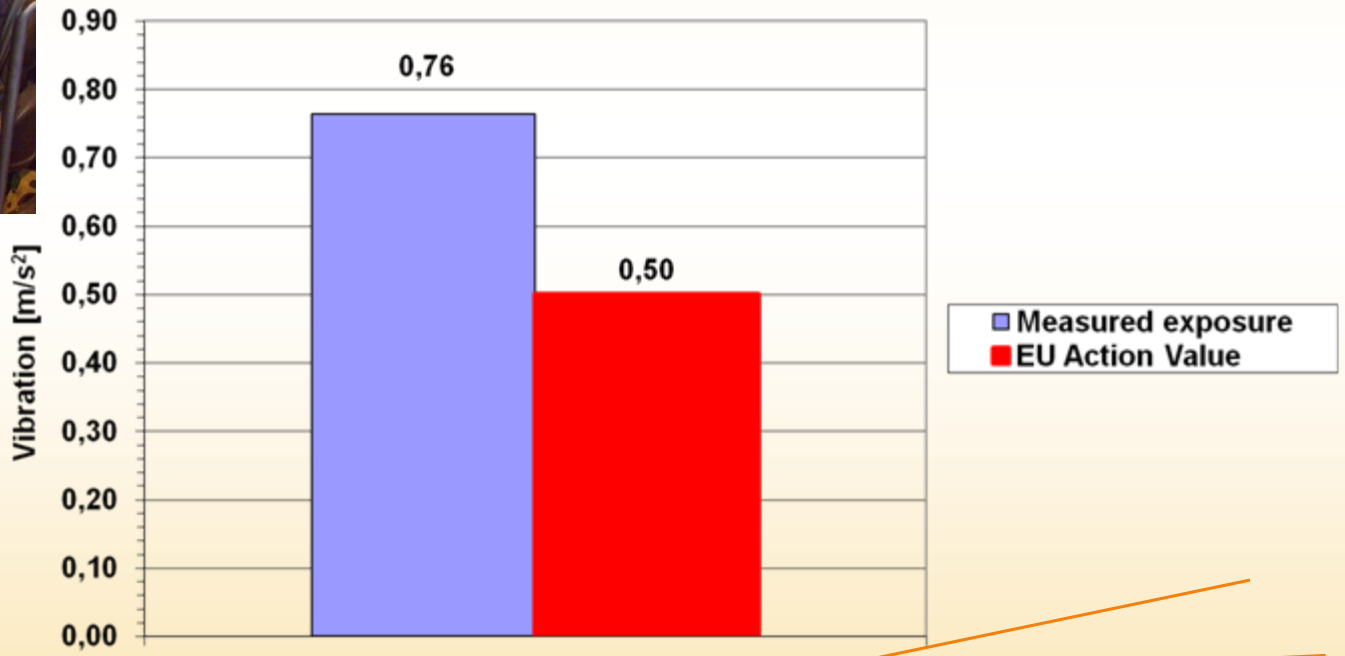
Videocamera for right of way.

Reference Measurement

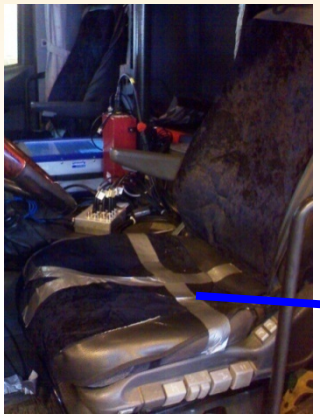
A laser / inertial Profilograph scanned the test road´s surface condition 20 000 times per meter.

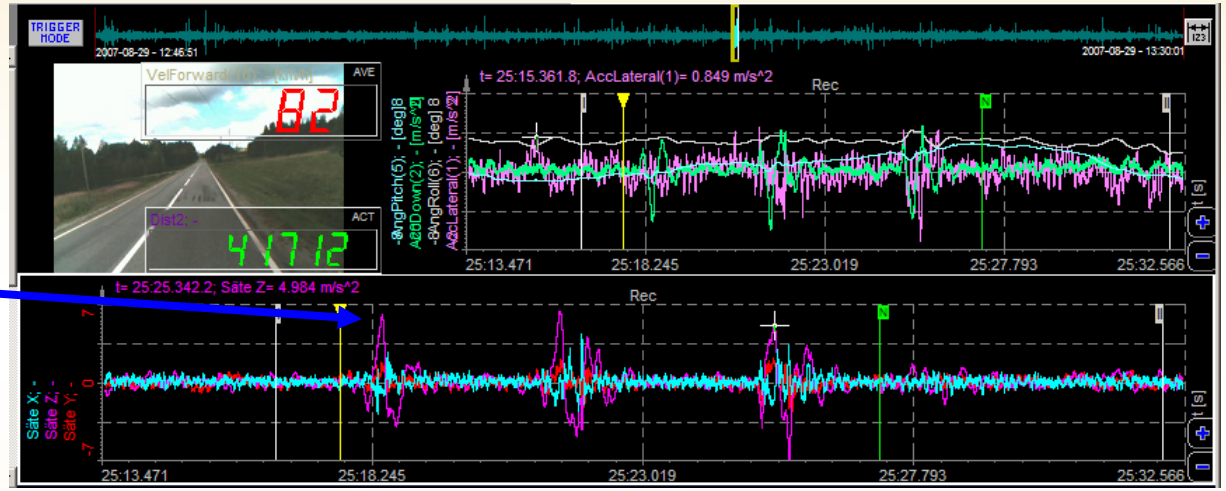
Results: 1. Daily vibration exposure A(8)

Results for normal driving shifts:
A(8) = 0.76 m/s².
Exceeding the EU Action Value 0.5 m/s².



2. Bumps gave high compression stress





Transient vibration may cause high compression stress in the spine; a special health risk.

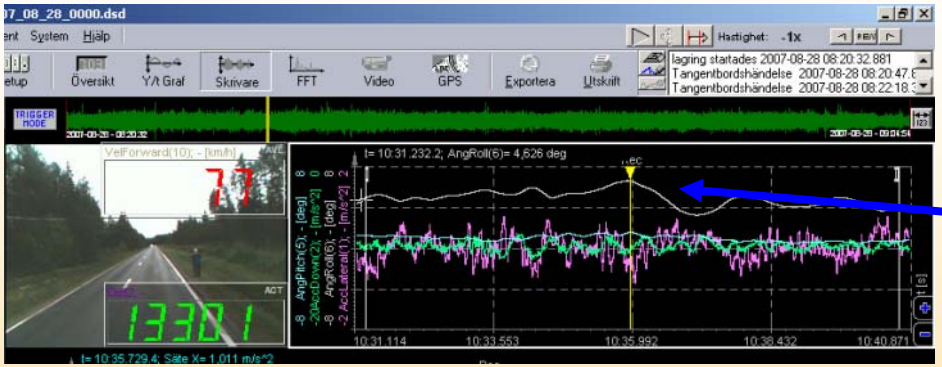
The worst bumps gave S_{ed} > 0.5 MPa in the spine.

This stress level corresponds to health risk, as per ISO 2631-5 (2004).

3. Rock n' Roll at Hazardous Sites

Straight road at HS Backe.

Note the snake rattling warping of truck versus trailer.



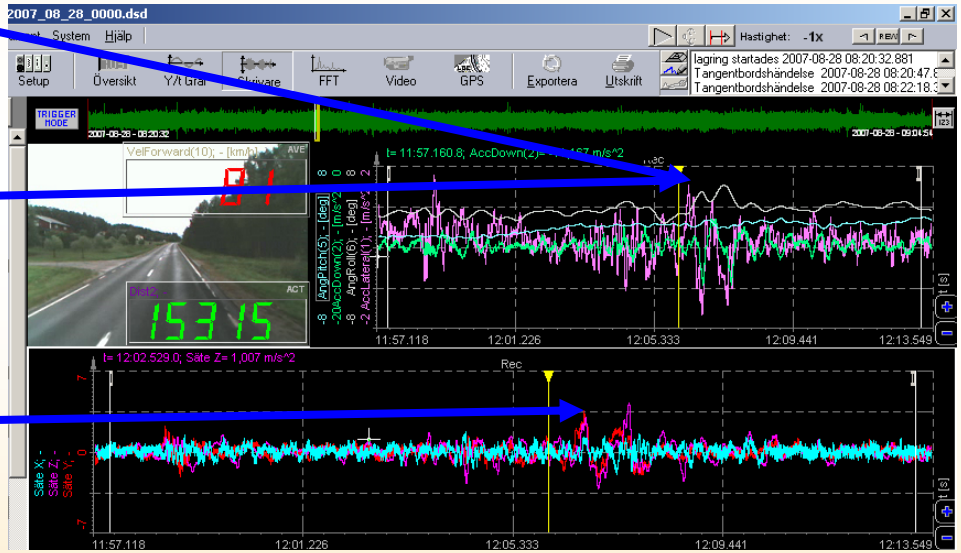
In-truck data: The cab roll angle changed with 3,5°/s.

Rock n' Roll at HS Åkerö

Truck cab roll angle:
- Very high rate; 5°/s.

High lateral acc in cab: 2 m/s².

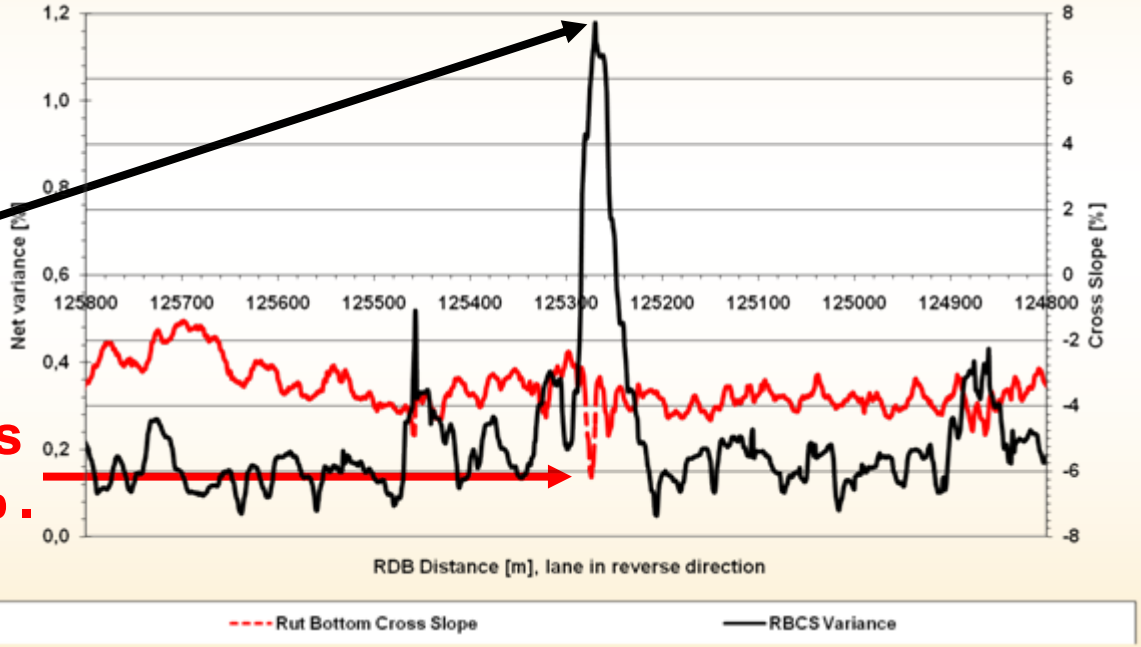
Very high lateral acc at driver seat : 3.5 m/s² (+ 75 %).



High RBCS variance at HS Åkerö

Alarm!
1.18 % RBCSV.

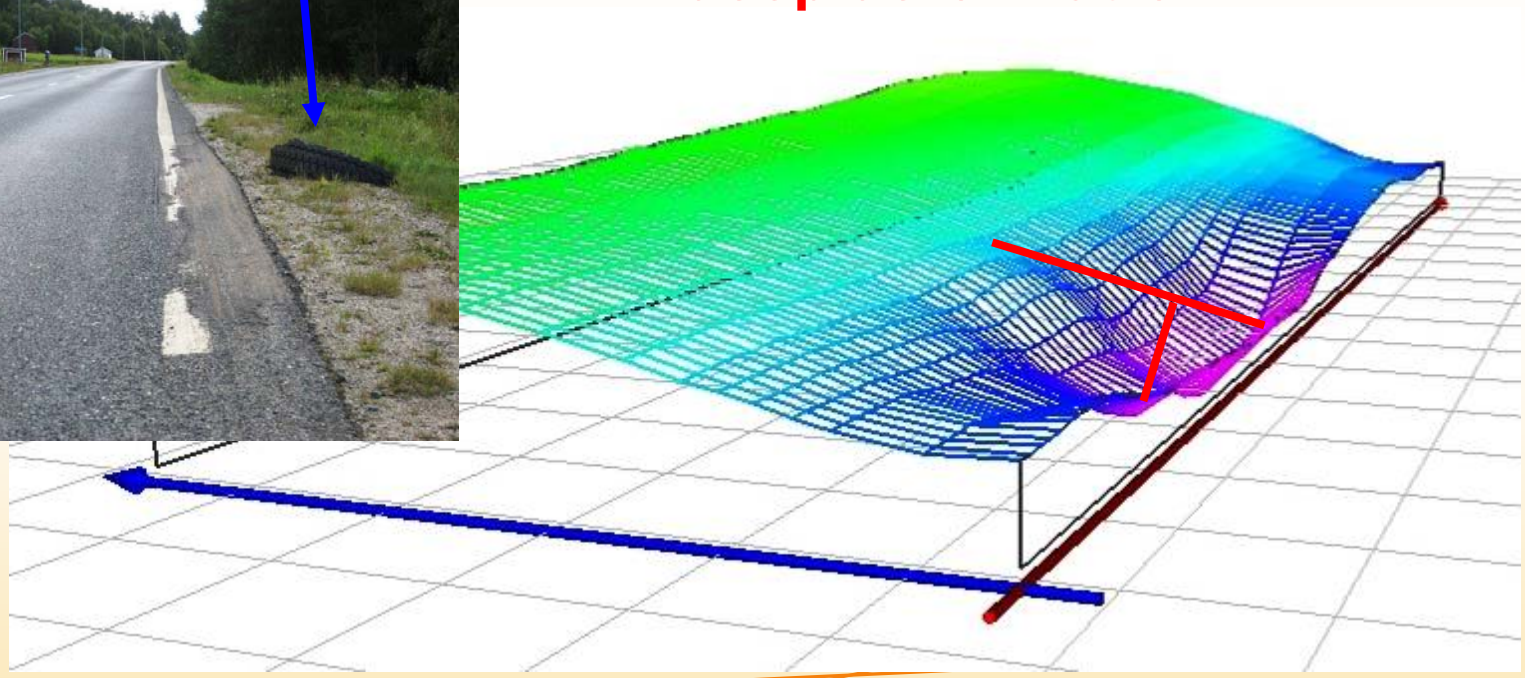
Cross slope warps from -3 to -6 %.



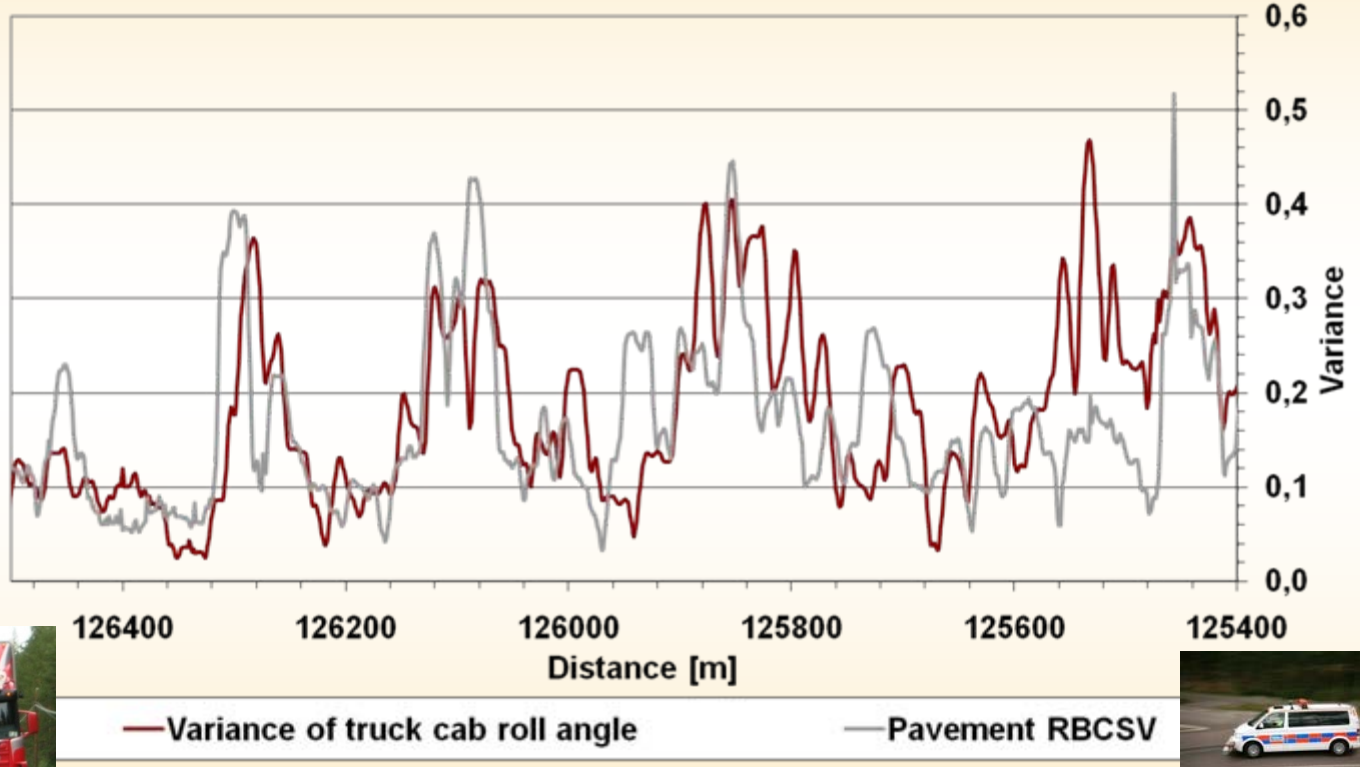
Profilograph 3D laserscan at HS Åkerö

Note: Exploded truck tire

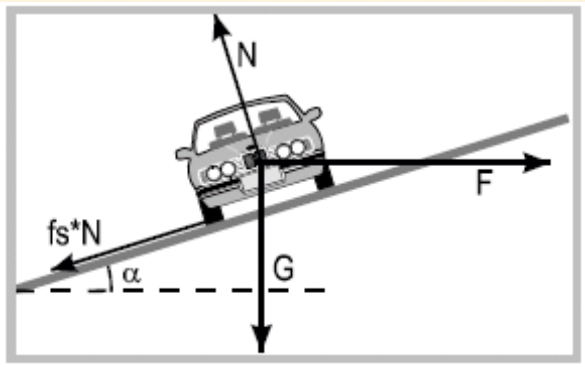
The 1.18 % RBCS variance was caused by a 69 mm deep deformation



Truck roll correlates with the RBCSV parameter



Recalling vehicle cornering forces



N = Normal force
tan(α) = Cross slope
F = Lateral force
G = Gravity
f_s = Lateral friction

The lateral force F is directly proportional to the road *Curvature*; 1000 / Radius.

Key reaction force factors:

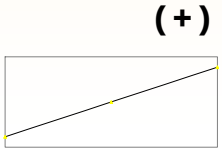
- **Friction (slippery surface: *Macrotexture*).**
- ***Cross slope*, a k a ”Banking” .**

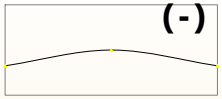
Ideal curves

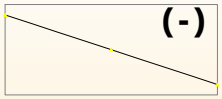
Swedish Design Guidelines for 90 km/h.

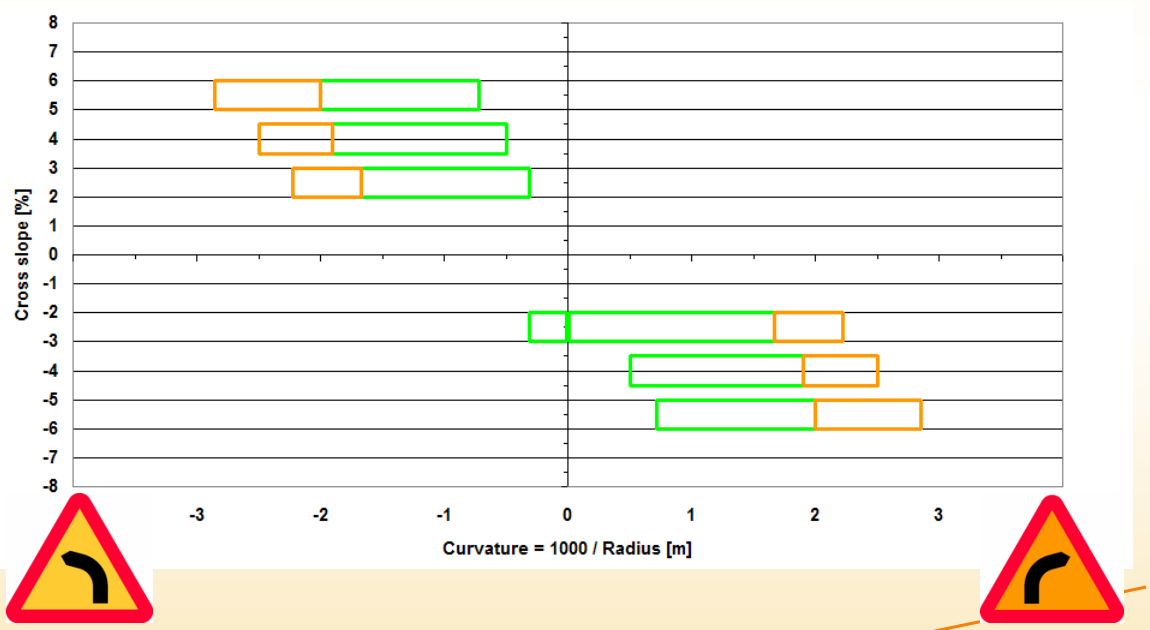
Values within green box = High standard.

Orange box = Moderate to Low standard.



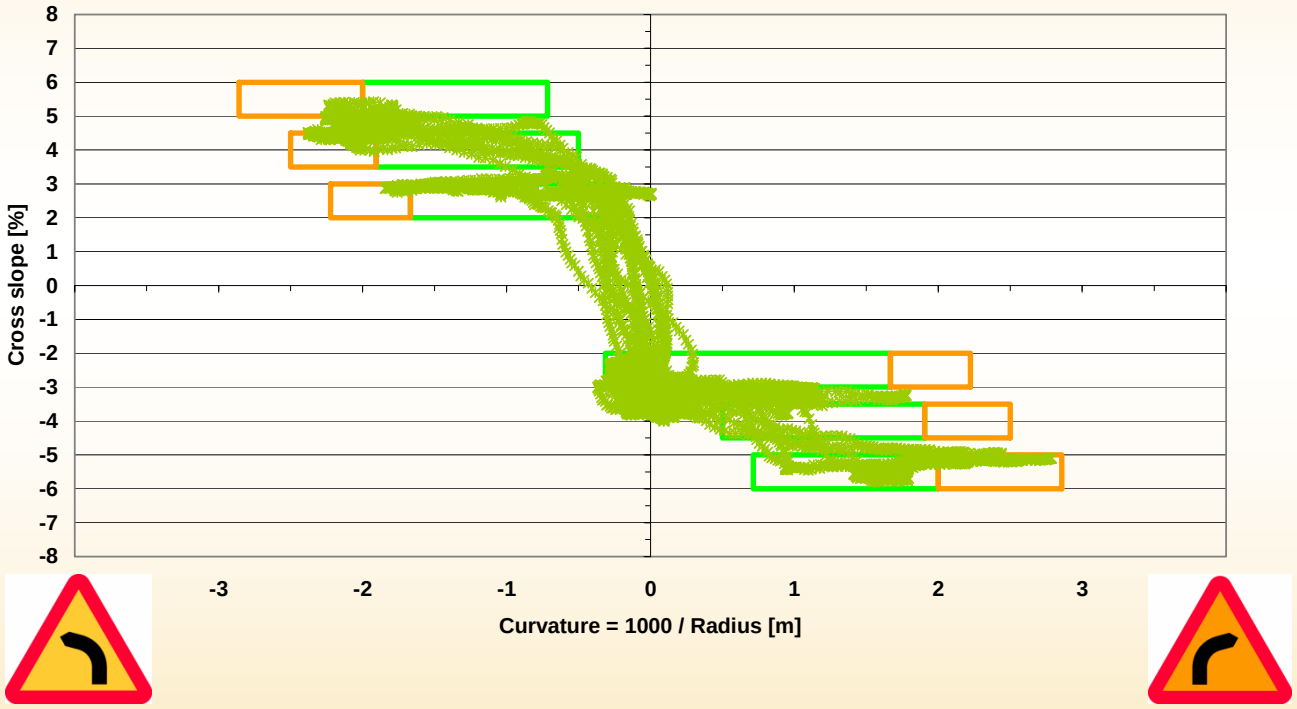






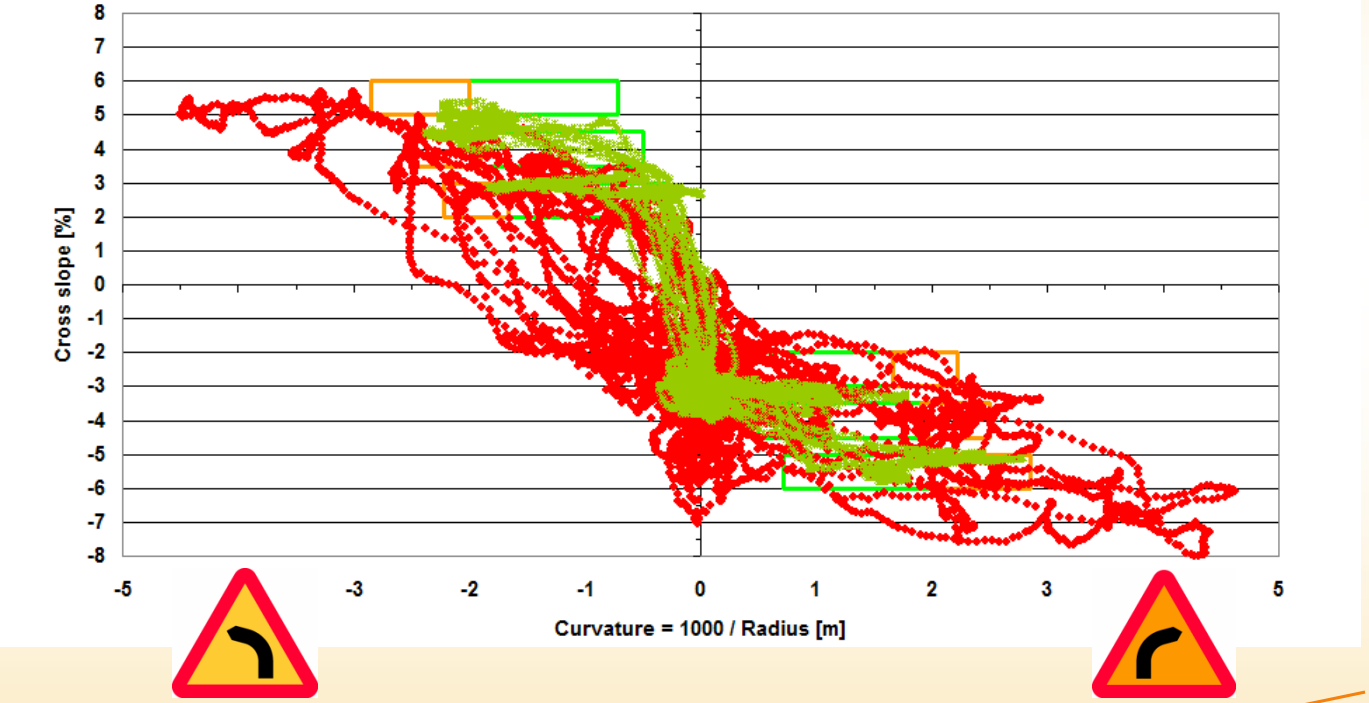
Reference Cross Slope vs Curvature

n = 12 300 reference data (1 m) from new Hw 90.

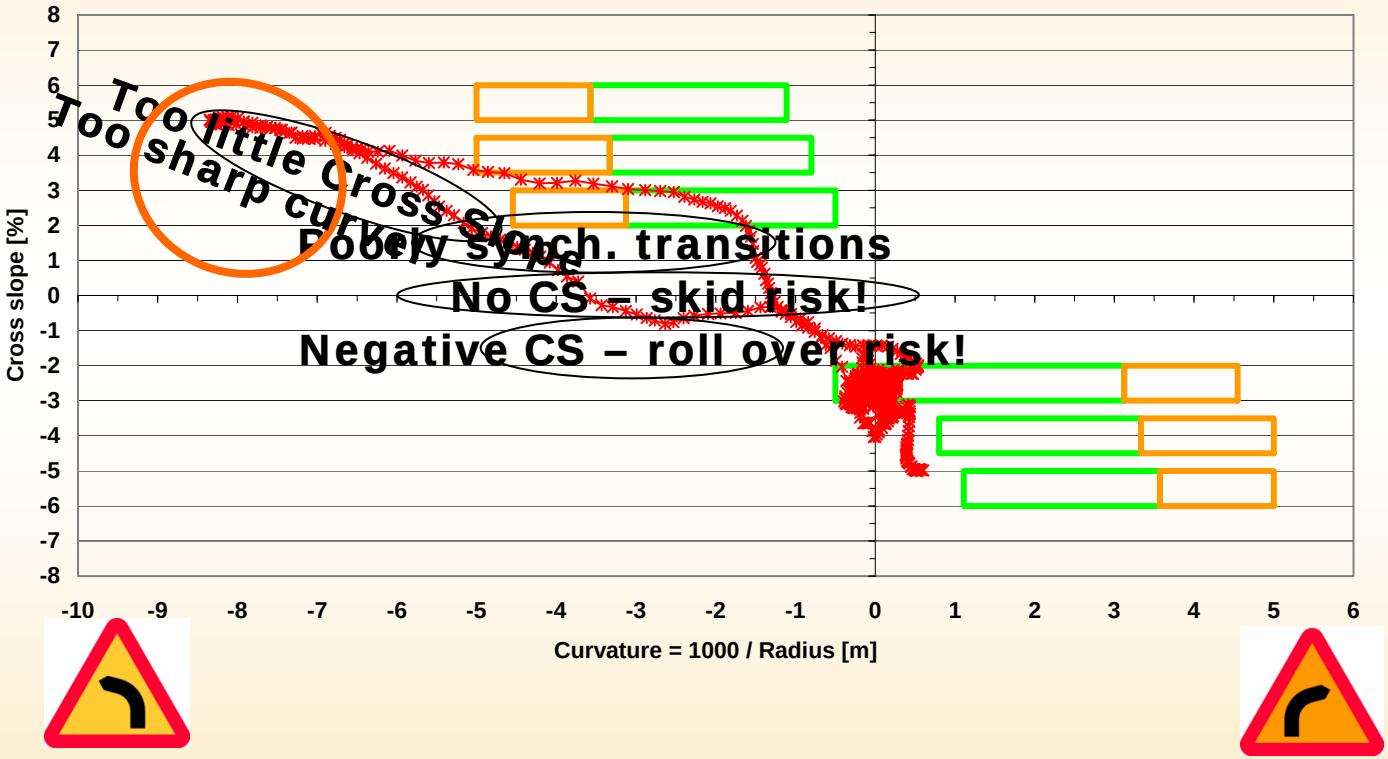


Rd 331: Improperly banked curves

n = 12 300 sections from old Rd 331.



Example: Hazardous Site Roos Curve



Conclusion on ride vibration

Truck ride vibration above the EU Action Value.

Bumps gave high compression stress in the spine.

Hauliers like Brorssons Åkeri AB are obliged, by EC member state laws, to make risk assessment and implement organizational and/or technical actions to minimize the driver´s vibration exposure.

These actions will bring significant costs to hauliers and their customers in the forest industry, et c.

Conclusion on lateral buffeting

High transient lateral forces at Hazardous Sites.

Road sections with high truck roll/lateral vibration are found with the new RBCSV parameter.

On heavy truck routes such as the Beaver Road 331, the pavement shoulders needs to be widened and strengthened.

Final conclusion on road safety issues

Roadex III has demonstrated methods to identify Hazardous Sites (HS) with improperly banked curves, insufficent Drainage Gradient in transition curves, Split Friction and many other deficiencies.

Road administrators are obliged to quickly identify HS, warn road users, and ASAP make relevant repair [*Tylösand Declaration*].

Thank you for your attention

Photo: Mats Landerberg